Tourist Spending Capacity and Greenhouse Gas Emissions: Evidence from European NUTS2 Regions

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Abstract

Tourism is among the most dynamic components of the global economy, yet its environmental implications remain contested once heterogeneity in tourism demand and spatial spillovers are properly taken into account. While a large cross-country literature documents positive associations between tourism expansion, energy use, and CO_2/GHG emissions within STIRPAT/EKC-type frameworks (León et al., 2014; Nepal et al., 2019; Salahodjaev et al., 2022; Khan et al., 2019), evidence is far from uniform and appears sensitive to income levels, energy mixes, and institutional settings (Aller et al., 2021). Moreover, aggregate national indicators conceal substantial within-country heterogeneity and overlook the fact that tourists differ systematically in spending capacity and consumption profiles. At the same time, emissions and economic activities exhibit spatial dependence, so that ignoring interregional interactions may bias inference and blur the geography of environmental pressures (Tobler, 1970; Elhorst, 2024). Building on these insights, this paper provides new evidence on the tourism–emissions nexus in Europe by combining a regional perspective with a disaggregated view of tourism demand and by explicitly modelling spatial interdependence.

We assemble a panel dataset of 238 NUTS2 regions in the European Union over 2014–2023, merging harmonised regional accounts, productivity indicators, and GHG emissions from ARDECO with regional tourism statistics from Eurostat. The outcome of interest is the logarithm of total GHG emissions from human activities in each region and year (thousand tonnes of CO_2 equivalent). The empirical design follows standard regional emissions models (Vagnini et al., 2024; Lodi and Bertarelli, 2024; Ketenci, 2021), controlling for the scale of economic activity via the logarithm of real GDP and its square, for economic structure via value added per capita in agriculture (NACE A) and in industry and energy (NACE B–E), and for technology/efficiency via labour productivity (real GDP per hour worked). Tourism intensity is proxied by annual tourist nights, disaggregated by accommodation type. Crucially, we distinguish between nights spent in hotels (NACE I551) and nights

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spent in other short-stay accommodation such as B&Bs, camping sites, and hostels (NACE I552–I553). After taking logarithms, these measures are interpreted as proxies for tourism segments with higher versus lower spending capacity, consistent with micro-level evidence linking accommodation choice to broader travel expenditures and consumption patterns (Park et al., 2020). This distinction allows us to go beyond treating tourism as homogeneous and to assess whether the composition of visitor flows matters for regional emissions.

Our baseline specification is a two-way fixed effects panel model with region and year fixed effects, estimated by within regression. The tourism coefficients capture within-region changes in emissions associated with changes in hotel-based and non-hotel tourism, net of time-invariant regional characteristics and common shocks. Given the well-documented spatial clustering of emissions, we complement the baseline model with spatial panel specifications. Descriptive evidence based on Moran's I indices for sectoral emissions and different greenhouse gases at yearly frequency points to pervasive spatial autocorrelation in European regional emissions, reinforcing the relevance of explicitly modelling the spatial component (Morelli et al., 2026). Accordingly, we estimate both a spatial error model, allowing for spatially correlated unobservables, and a spatial lag model, allowing emissions in one region to depend directly on emissions in neighbouring regions. Spatial proximity is captured through a row-normalised k-nearest-neighbours weights matrix (baseline $k = 20$, with robustness checks using $k = 10$), in line with recent spatial panel practice (Elhorst, 2010; Millo, 2014). This framework is well suited to integrated areas such as Europe, where economic linkages, shared infrastructures, and policy diffusion can generate cross-border externalities.

Across all model variants, the results highlight two main findings. First, hotel nights (our proxy for higher-spending tourism) are consistently associated with slightly lower total GHG emissions. The estimated coefficient on hotel nights is negative in the fixed effects model and remains negative in both spatial specifications; it is statistically significant at conventional levels in the fixed effects and spatial lag models and close to the 10% threshold in the spatial error model. Second, nights spent in other accommodation types (our proxy for lower-spending tourism) show a positive but generally imprecisely estimated relationship with total emissions, with p-values that hover around but typically exceed conventional significance thresholds. Conditional on income, sectoral structure, productivity, and fixed effects, these patterns suggest that regions experiencing increases in hotel-based tourism tend to record small reductions in total emissions relative to otherwise comparable years, whereas increases in non-hotel stays do not exhibit a clear and robust association with total emissions. Importantly, the spatial parameters in the spatial error and spatial lag models are positive and highly significant, indicating that emissions co-move across neighbouring regions and that accounting for spatial interdependence is empirically meaningful in this setting.

To shed light on potential mechanisms and to locate where in the emissions system tourism-related variation is most salient, we further re-estimate the models using source-specific GHG emissions as dependent variables, focusing on Agriculture, Buildings, Energy, Industry, Transport, and Waste. We summarise these estimates visually and formally test whether the coefficients on hotel nights and other nights differ within each sector. The difference is statistically significant for total emissions and, most notably, for Buildings, indicating that the contrast between higher- and lower-spending tourism is largely mediated through building-related emissions. This pattern is consistent with the notion that accommodation types can differ in their emissions intensity: hotels may operate with relatively higher energy efficiency or exhibit scale economies in heating/cooling and hot-water provision, while also potentially facing stronger incentives to adopt energy-management systems and efficiency upgrades. At the same time, sectoral estimates indicate that high-spending tourism is associated with higher emissions from Transport and Waste, with coefficients significantly larger than those for low-spending tourism. This result is consistent with the possibility that higher-spending visitors adopt mobility choices that are more carbon-intensive (e.g., rental cars, private transfers, taxis/ride-hailing) and consumption patterns that generate more waste. In contrast, coefficients for Agriculture, Industry, and public-use Energy are comparatively muted and not precisely estimated, which is consistent with these sources being driven mainly by production structures and public infrastructure that are less responsive to short-run fluctuations in tourism flows at the regional level. Overall, the sectoral decomposition suggests that the tourism–emissions nexus is source-specific and that the composition of tourism demand matters for how environmental pressures manifest across sectors.

Our findings contribute to three strands of the literature. First, they complement cross-country evidence by providing a within-Europe regional analysis that is sensitive to spatial dependence and within-country heterogeneity. Second, they extend work that uses accounting and sectoral approaches to identify channels (Sharp et al., 2016; Cai, 2016; Konan and Chan, 2010) by showing that, within the emissions system, the accommodation channel (Buildings) and the mobility/waste channels (Transport and Waste) appear most responsive to tourism composition. Third, they speak to emerging spatial econometric contributions documenting cross-border linkages in environmental outcomes (Li and Lv, 2021; Dong et al., 2023), reinforcing the view that tourism-related environmental pressures can propagate across administrative boundaries and that spatial modelling is central for credible inference in integrated regions.

From a policy perspective, the results point to targeted levers rather than uniform prescriptions. If the relative expansion of hotel-based tourism is associated with lower building-related emissions, this suggests that energy-efficiency standards, retrofitting incentives, and certification schemes in the accommodation sector may play a role in moderating the footprint of tourism growth. Conversely, the positive association between high-spending tourism and Transport/Waste emissions suggests that mobility management (public transport attractiveness, multimodal integration, low-emission zones, electrified shared mobility) and waste policies (recycling infrastructure, circular-economy practices in hospitality and services) are likely to be crucial complements to accommodation-focused measures. At the same time, the presence of statistically significant spatial dependence implies that policy design should be spatially coordinated: interventions in one region may affect outcomes in neighbouring areas through commuting corridors, shared supply chains, or spillovers in technology adoption and regulatory practices. These conclusions align with the broader sustainable tourism policy debate, where transport is widely recognised as a dominant emissions source (Cavallaro et al., 2017) and where the effectiveness of environmental pricing and incentives depends on behavioural responses and institutional context (Bigerna et al., 2019).

Several limitations also motivate future work. While accommodation type provides an empirically tractable proxy for spending capacity, it remains an imperfect measure of tourist behaviour and environmental preferences. More granular data on lodging characteristics (size, occupancy, vintage, renovations, energy carriers, certification status) would help distinguish whether the Buildings-channel differences reflect efficiency, composition, or scale effects. Similarly, interpreting the Transport and Waste patterns would benefit from data on mode choice, trip distances, and within-destination mobility, as well as more detailed waste-generation indicators. Finally, heterogeneous effects across destination types (coastal versus inland, urban versus rural, tourism-specialised versus diversified regions) and interactions with local energy mixes and environmental policies can be formally tested within the spatial panel framework. As a next step, we are collecting province-level data for Italy on energy consumption and tourist presences to sharpen the empirical link between tourism flows with different spending capacities and energy demand by source and carrier. Overall, by combining regional data, disaggregated tourism proxies, and spatial econometric methods, this paper provides evidence that the environmental footprint of tourism in Europe depends not only on how much tourism a region receives, but also on what type of tourism it attracts and how these effects propagate across space.

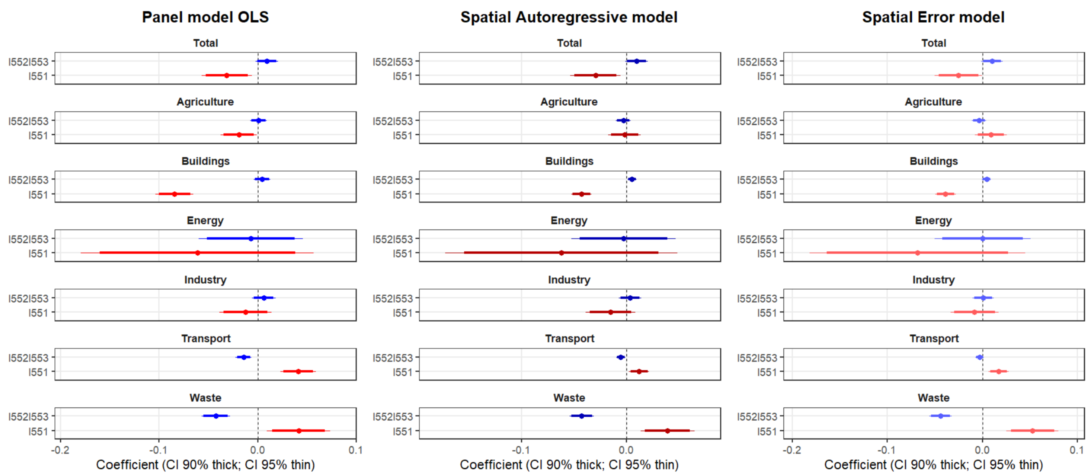

Figure 1: Impact of high- and low-spending tourism flows on GHG emissions by source. Red (blue) intervals refer to the estimated coefficients for hotel nights (other short-stay nights). Thick (thin) lines denote 95% (90%) confidence intervals.

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